Emergency Avalanche Transceiver Garment

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Project Design Objective

- Develop garments that minimize inference and/or “boost” an avalanche beacon’s signal for backcountry winter sport use.
- Our focus:
  - Beacon placement (chest vs. pants)
    - User preference testing
  - Limiting interference from other devices (such as cell phones)
    - Material testing and creating a designated cell signal blocking pocket
  - Securely containing the avalanche beacon
    - Harness system
  - Maintaining the mobility of the wearer
    - Mobility testing

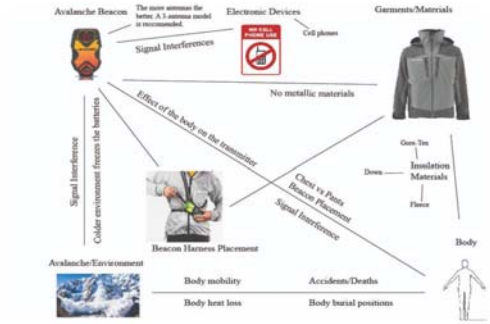
Project Design Statement

- Currently, there are no garments/products on the market that combat interference with avalanche beacon effectiveness and/or boost the beacon’s signal. Traditionally, avalanche beacons are worn on the chest. Due to the trending pant placement of avalanche beacons, further examinations and comparison of the beacon’s placement is needed to help inform which placement is best for the beacon’s signal and security.
- Patagonia, Inc. was the sponsor for this project brief and provided materials to aid in research testing and prototyping.

Background Research Findings

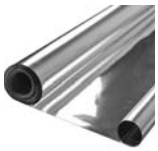
- An avalanche beacon is an emergency locator device used by people who partake in backcountry winter activities. Everybody in the party should wear one when they go out. Initially they are set to ‘send’ mode which emits a signal. If an avalanche occurs, those in the party who are safe are to set their beacon to ‘search’ mode which can then pick up the signals from the beacon’s of those in danger to help locate the victims.
- When buried under snow the body has no mobility. Majority of avalanche victims are found downhill with their face facing the ground. Common cause of deaths are due to lack of oxygen. Buried victims are estimated to die within 35 minutes without air. The survival rate is higher if victims are found in 15 minutes.
- Various electronic devices like cell phone, camera can interfere with the signal of the beacon, whereas gears like shovel can partially block the signal or create spikes.
- The only product on the market currently designed for an avalanche beacon is a pair of pants available from Outdoor Research.
- Metallic materials (aluminum and copper) must not be used in the design as to not interfere with the signals from the avalanche beacon.
- Frequencies can come in the form of active [(actively transmitting frequencies like our cell phone which block signals) and passive interference (partially blocking the signal like metal, aluminum).

Design Framework

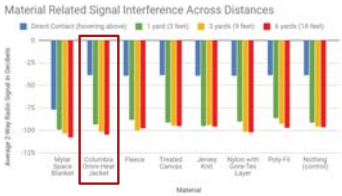


Signal Blocking Materials

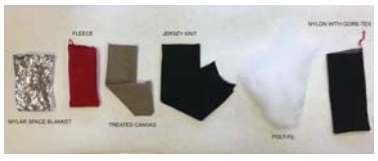
- **Aluminized Mylar:** Transparent PET (Polyethylene terephthalate) film with a reflective aluminum coating.
  - Absolutely does dramatically reduce the amount of EMF radiation if the mylar is placed between you and the source of the radiation. However it in most cases it will not block 100% of it, more likely around 95% or more.
- **Faraday Fabric:** Woven polyester fabric with copper/nickel coating
  - Designed as an EMF-shielding product



Interference from Textile Materials

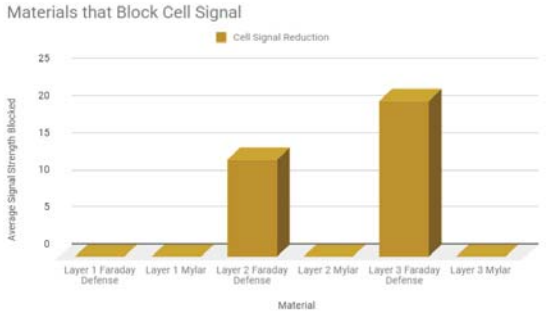


Assessment of interference of various textile materials. Concluded that a continuous metallic surface is needed for signal blocking to take place.

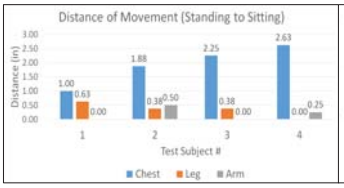


Formative Research and Development

Interpretation: A fully-enclosed cover of Faraday Defense fabric works better than aluminized Mylar in blocking cell signal of electronic devices



Wearability Research: Beacon Placement (Body)

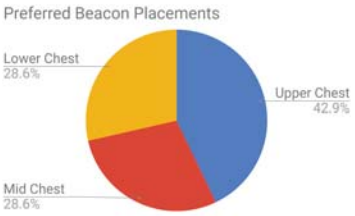


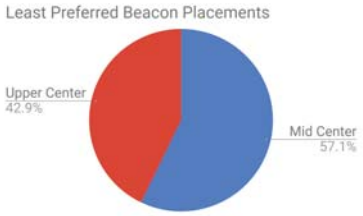
Key	Comfort Lvl.
0	No comfort
1	Little comfort
2	Some comfort
3	Comfortable
4	Very comfortable

Security and comfort was important. In our initial tests we found that placing the beacon in a pocket on the leg and arm moved the least compared to the chest harness. Placing the beacon on the leg was the most comfortable. Although the results shows that placing the beacon on the leg would be a good idea, we decided to carry on with the chest placement. This is due to the fact that the chest area is easier to access and protect the beacon.

Wearability Research: Beacon Placement (Chest)

The data collected from the first chart concludes that approximately half of the test users preferred the placement of the beacon on the upper chest. The second chart displays the least preferred placements, which terminated that the beacon should not be placed on the upper chest center and mid chest center.





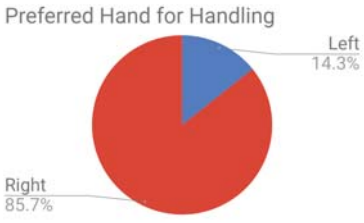
Wearability Research: Beacon Placement (Chest)

For our alternative testing, we did an in-depth testing of different beacon placements on the chest to determine where on the upper body will be best for consumers.

Wearability Research: Handling Beacon

Test participants were asked during the experimentation which hand they preferred to get the beacon out of the pocket

This chart shows that most test users preferred using their right hand to handle the beacon, therefore the beacon will be placed on the upper left chest for ease of reach.



Test Garment: Pattern Development + Construction

Images showing the first round test garment that was made using muslin and canvas fabrics. Was created to test the design of the built-in harness, the designated avalanche beacon pocket, and the side pocket for the cell signal blocking pocket.

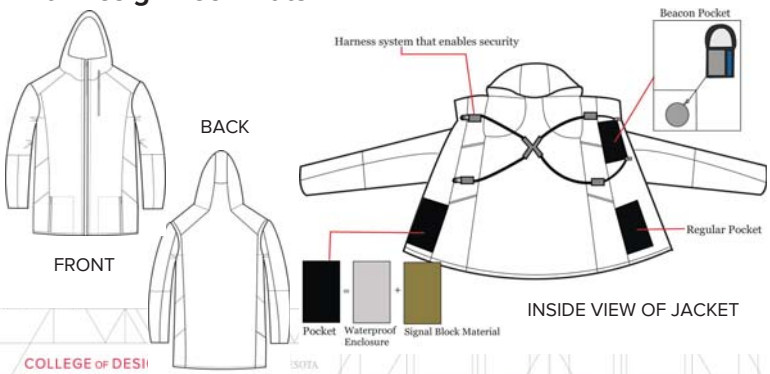
Final Design Description

- On the inside there is an integrated harness system to keep the beacon pocket and jacket secure on the body. This is through using adjustable elastic straps and plastic buckle clips.
- Fabrics included in our final prototype were:
  - heavy black Nylon Ripstop with a Gore-Tex membrane
  - lightweight black Nylon Ripstop
  - black knit Jersey
  - cell signal blocking Faraday Defense material
  - clear plastic to make the cell signal pocket waterproof

Final Design Description

- Our final jacket shell prototype features a designated avalanche beacon pocket on the upper left chest area. That pocket includes a retractable badge reel attached to the beacon and pocket for extra security.
- There are two lower side seam pockets. The one on the right side is designated for blocking cell signals that might inhibit the beacon's effectiveness.
- All of the pockets are closed with zippers and there is a center front zipper on the jacket.

Final Design Tech Flats



Final Design Prototype




Evaluation

- Our jacket was created to be the main shell layer that a person would take with them in the backcountry for either skiing or snowboarding. It was meant to serve as an all-in-one combination of both avalanche beacon harness and jacket.
- We needed to find a fabric material that would provide protection in avalanche conditions, leading us to choose a fabric with Gore-Tex in it due to its insulating and waterproof properties. Our fabric choice was similar to what Patagonia uses in the market today.
- For the signal blocking pocket, we needed to find a material that provided a continuous metallic surface but one that wouldn't interfere with the avalanche beacon's signal. That came in the form of the Faraday Defense material, which is a woven polyester fabric with copper/nickel coating. We wanted to include a pocket on the jacket that the user could slip their phone into and have its signals not interfere with the avalanche beacon's signals. This also came into the location choice of the pocket; we picked the location that would be furthest away from the beacon and still make sense (lower right side seam). The fabric was effective and the pocket wouldn't have been successful without it.

Final Design Prototype

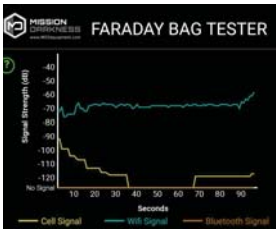


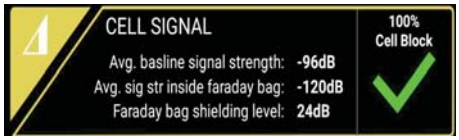
Evaluation - Jacket



- Tests on our final included mobility tests such as arm rotations, jumping jacks, and stretching
- Testing on our final prototype concluded that:
  - Chest pocket is secured due to the elastic strapping, stabilization of pocket, and wearer awareness. Met our goal of '*Beacon placement must be considered in the design.*'
  - Chest pocket and elastic fastenings contained beacon and limited beacon movement. Met our goal of '*Final design has to contain an avalanche beacon.*'
  - Chest placement allowed mobility. Met our goal of '*Design should not restrict the mobility of the wearer.*'

Evaluation - Cell Signal Blocking Pocket





The cell signal blocking pocket (made of the Faraday Defense fabric) successfully worked. This means that the design limits interference between the beacon and cell phone devices.

Consumer Translation Design

Consumer Translation Design

- In addition to our jacket design, we created a consumer translation design.
- This vest includes the secure and adjustable elastic harness fastening from our jacket, along with the retractable badge reel attachment.
- The intended purpose was to create a fashionable streetwear inspired garment for outdoor activities that had the essence of our jacket in both function and aesthetics, but could be used by a wider audience.
- Unisex and seasonless.
- Materials used include black lightweight nylon ripstop, elastic straps, buckle clips, and a badge reel.
- Fabric was required to give the user the most adaptability in changing the size via the strap adjustments. The fabric was light enough but sturdy enough to move with the body.